

WHAT IS CLAIMED IS:

1. Rechargeable lithium battery having a maximum permissible cell voltage
for use in the intended manner, comprising

5

an anode comprising a material which is capable of incorporating lithium
ions and releasing them again,

10

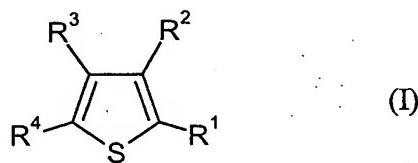
a cathode comprising a material which is capable of releasing lithium ions
and incorporating them again,

a separator,

15

a nonaqueous electrolyte comprising one or more solvents and one or more
conductive salts optionally embedded in a polymeric gel matrix,

characterized in that the nonaqueous electrolyte additionally comprises a
thiophene of the general formula (I)



in which

25

R¹ to R⁴, independently of one another, are H, C₁-C₁₈-alkyl, C₁-C₁₈-haloalkyl, C₁-C₁₈-alkoxy, C₁-C₁₈-haloalkoxy, halogen or pseudohalogen, with the proviso that at least one of the radicals R¹ to R⁴ is CN.

2. Rechargeable lithium battery according to Claim 1, characterized in that R¹ to R⁴, independently of one another, are H, C₁-C₆-alkyl, C₁-C₆-fluoroalkyl, C₁-C₆-alkoxy, C₁-C₆-fluoroalkoxy, F, Cl or CN, with the proviso that at least one of the radicals R¹ to R⁴ is CN.
5
3. Rechargeable lithium battery according to Claim 1, characterized in that R¹ to R⁴, independently of one another, are H, with the proviso that at least one of the radicals R¹ to R⁴ is CN.
- 10 4. Rechargeable lithium battery according to Claim 1, characterized in that the nonaqueous electrolyte comprises a thiophene of the general formula (I) in an amount of from 0.01 to 10% by volume.
- 15 5. Rechargeable lithium battery according to Claim 1, characterized in that the nonaqueous electrolyte comprises a thiophene of the general formula (I) in an amount of from 2 to 5% by volume.
6. Rechargeable lithium battery according to Claim 1, characterized in that the anode comprises
20 metallic lithium or
alloys containing metallic lithium or
25 carbon-like optionally graphitic or non-graphitic materials or
carbon-based materials which contain further nonmetallic components in addition to carbon, or
30 ternary compounds of boron, carbon and nitrogen or

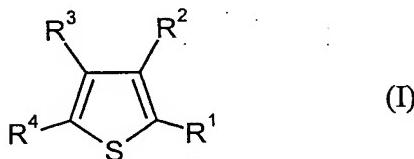
oxides or sulphides of main group and subgroup elements.

7. Rechargeable lithium battery according to Claim 1, characterized in that the cathode comprises one or more transition metal chalcogenides or one or more mixed oxides of lithium and one or more transition metals and/or main group metals.
5
 8. Rechargeable lithium battery according to Claim 1, characterized in that the cathode comprises $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$, $\text{LiNi}_{1-y}\text{Co}_x\text{Al}_y\text{O}_2$ or LiNi_{1-x}
10 $\text{zCo}_x\text{Mn}_z\text{O}_2$,
- in which
- 15 x is a number from 0.05 to 0.5,
 y is a number from 0 to 0.3 and
 z is a number from 0 to 0.5,
- 20 or mixtures of these with one another or mixtures of these with other mixed oxides of lithium with transition metals and/or main group metals.
9. Rechargeable lithium battery according to Claim 1, characterized in that the separator is a porous polymer membrane or porous glass.
25
 10. Rechargeable lithium battery according to Claim 1, characterized in that the nonaqueous electrolyte comprises one or more solvents selected from the group of the esters of carbonic acid, esters or nitriles of carboxylic acids, lactones, ethers, alkanes, and perfluorinated alkanes, and one or
30 more conductive salt(s) selected from LiBF_4 , LiPF_6 , LiAsF_6 , LiClO_4 ,

lithium salts of perfluorinated carboxylic acids and perfluorinated
alkanesulphonic or arylsulphonic acids, lithium-bisfluoroalkylsulphonyl-
imides, lithium-trisfluoroalkylsulphonylmethides, lithium fluoroalkyl-
phosphates, lithium bis(oxalato)borates, and lithium
5 bis((salicylato)borates) optionally embedded in a polymeric gel matrix.

11. Rechargeable lithium battery according to Claim 1, characterized in that
the nonaqueous electrolyte comprises, as a solvent, ethylene carbonate,
propylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl
10 carbonate or vinylene carbonate or a mixture of at least two of these
carbonic esters.
12. Rechargeable lithium battery according to Claim 1, characterized in that
the maximum permissible cell voltage for use in the intended manner is 4
15 V or higher.
13. A process for protecting rechargeable lithium batteries having a maximum
permissible cell voltage for use in the intended manner from overcharging
comprising adding thiophenes of the general formula (I)

20

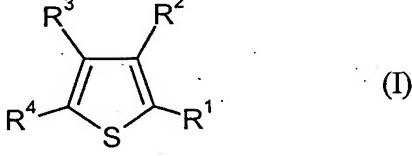


in which R¹ to R⁴ have the meaning mentioned in Claim 1,

25 as an additive for nonaqueous electrolytes.

14. The process according to Claim 13, characterized by the rechargeable
lithium batteries having a maximum permissible cell voltage of 4 V or
higher for use in the intended manner.

15. Method for preventing the overcharging of rechargeable lithium batteries having a maximum permissible cell voltage for use in the intended manner, comprising an anode substantially comprising a material which is capable of incorporating lithium ions and releasing them again,
5
an anode comprising a material which is capable of incorporating lithium ions and releasing them again,
10 a cathode comprising a material which is capable of releasing lithium ions and incorporating them again,
a separator,
15 a nonaqueous electrolyte comprising one or more solvents and one or more conductive salts optionally embedded in a polymeric gel matrix,
comprising adding a thiophene of the general formula (I)



20

in which

R¹ to R⁴ have the meaning mentioned in Claim 1,

25

to the nonaqueous electrolyte, which thiophene undergoes a chemical reaction at a voltage which is greater than the maximum permissible cell

voltage of the battery for use in the intended manner, with the result that overcharging of the battery is counteracted.

16. Method according to Claim 15, characterized in that the thiophene of the
5 general formula (I) is added to the electrolyte in an amount of from 0.01 to 10% by volume.
17. Method according to Claim 15, characterized in that the thiophene of the
10 general formula (I) is added to the electrolyte in an amount of from 2 to 5% by volume.
18. Method according to Claim 15, characterized in that the maximum permissible cell voltage of the battery for use in the intended manner is 4 V or higher.
15
19. Method according to Claim 15, characterized in that the voltage at which the thiophene of the general formula (I) undergoes chemical reaction is 4.7 V or higher.